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Indian Standard

SPECIFICATION FOR DC MOTORS FOR AIRCRAFT

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NEW DELHI 110002

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Indian Standard

SPECIFICATION FOR DC MOTORS FOR AIRCRAFT

Aircraft Electrical Equipment Sectional Committee, ETDC 55

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Indian Standard

SPECIFICATION FOR DC MOTORS FOR AIRCRAFT

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 26 July 1982, after the draft finalized by the Aircraft Electrical Equipment Sectional Committee had been approved by the Electrotechnical Division Council.

0.2 This standard covers the general requirements and methods of tests for dc motors intended for use in aircraft.

0.3 This standard shall be read in conjunction with IS : 8946-1978*.

0.4 In the preparation of this standard, considerable assistance has been derived from 'BS : 2G-146 DC motors for aircraft', issued by the British Standards Institution.

0.5 For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test, shall be rounded off in accordance with IS : 2-1960†. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

1. SCOPE

1.1 This standard specifies the general aspects of design, construction, methods of tests and performance requirements of dc motors for use in aircraft.

1.2 This standard does not cover engine starter motors.

2. TERMINOLOGY

2.0 For the purpose of this standard, the following definitions in addition to those given in IS : 4722-1968‡ shall apply.

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*General requirements for rotating electrical machinery for aircraft.

†Rules for rounding off numerical values (*revised*).

‡Specification for rotating electrical machines.

2.1 Rating — The operating limitations assigned to the motor by the manufacturer.

2.2 Rated Speed and Torque — The speed and torque declared by the manufacturer for nominal voltage.

2.3 Time Rating — The time for which the motor can be operated at rated torque without exceeding the temperature limits.

2.4 Type Tests — Tests carried out to prove conformity with the requirements of this standard. These are intended to prove the general qualities and design of a given type of dc motor.

2.5 Routine Tests — Tests carried out on each dc motor to check the essential requirements which are likely to vary during production.

3. GENERAL REQUIREMENTS, DESIGN AND CONSTRUCTION

3.1 Voltage

3.1.1 The terminal voltage shall be in accordance with IS : 7854-1975* as applied to aircraft electrical systems.

3.1.2 The motor shall be capable of operating at the following normal rated load condition at steady temperature.

3.1.2.1 The motor shall be capable of sustaining 150 percent of rated torque at minimum speed drawing proportionate current for a period of at least 20 min. The occurrence of such overload may be twice in an hour.

3.1.2.2 The motor shall be capable of producing 300 percent of rated torque tor a period of 10 s.

3.1.2.3 The motor shall be capable of running up to a speed of 125 percent of rated speed when required, for a period up to 3 min without any detriment or failure.

3.1.3 *Cooling and Mounting Arrangements*

3.1.3.1 The arrangement for cooling, mounting and drive shall be as agreed upon between the manufacturer and the purchaser, but otherwise generally shall conform to IS : 8946-1978†.

3.1.3.2 There shall preferably be no limitation in the performance of the motor in respect of the altitude in which it may be mounted. Such limitation, if any, shall be declared.

3.1.4 The design and construction of the motor shall comply with IS : 8946-1978†.

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*Voltages and frequency for aircraft electrical systems.

†General requirements for rotating electrical machinery for aircraft.

3.1.4.1 The design aim shall be to achieve 3 000 (aircraft) hours operation of the motor before maintenance.

3.1.4.2 *Electrical connections* — Terminals shall be provided for each of the connecting leads of winding and input supply terminals.

3.1.4.3 Provision shall be made in the terminal box for effecting changes in the direction of rotation in the case of reversible motor. Clear and permanent indication of correct connection in conformity with the marking practices of IS : 4728-1975* shall be given in the terminal box including marking for reversing.

3.1.4.4 Provision shall be made for internal radio interference suppression in the motor, or attachment suitable for screened cable shall be given. Any coil or winding connected in series with the armature shall preferably be disposed symmetrically in the armature circuit.

3.1.4.5 The starting system shall be simple, efficient and robust.

4. DECLARATION OF DESIGN AND PERFORMANCE

4.1 The continuous rated output of the motor under declared conditions of speed, altitude and cooling shall be declared by the manufacturer in the form specified in IS : 7855-1975†.

4.2 Power required to deliver the nominal rated output and the polar moment of inertia of the motor shall also be indicated in the form.

5. MARKING

5.1 The manufacturer shall provide the following information in regard to the motor:

a) Rated torque(s), speeds and direction of rotation;
b) Rated voltage;
c) Time ratings; and
d) Cooling requirement.

6. TESTS

6.0 Classification of Tests

6.0.1 *Type Tests* — The following shall constitute type tests:

a) Preliminary inspection (**6.1.1**),
b) Cold resistance test (**6.1.2**),

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*Specification for terminal marking and direction of rotating electrical machinery (*first revision*).

†Form of declaration of performance of aircraft electrical equipment.

c) Load test (**6.1.3**),

d) Stall test (**6.1.4**),

e) Temperature test (**6.1.5**),

f) Commutation test (**6.1.6**),

g) Overload test (**6.1.7**),

h) Insulation resistance test (**6.1.8**),

j) Altitude test (**6.1.9**),

k) Endurance test (**6.1.10**),

m) Acceleration test (**6.1.11**),

n) Vibration test (**6.1.12**),

p) Temperature, pressure test (**6.1.13**),

q) Environmental tests (**6.1.14**),

r) Radio-interference test (**6.1.15**), and

s) Compass interference test (**6.1.16**).

6.0.2 *Routine Tests* — The following shall constitute routine tests:

a) Component check (**6.2.1**),

b) Resistance test (**6.2.2**),

c) Preliminary run test (**6.2.3**),

d) Over-speed test (**6.2.4**),

e) Load test (**6.2.5**),

f) Insulation resistance test (**6.2.6**),

g) High voltage test (**6.2.7**),

h) Temperature test (**6.2.8**),

j) Environmental tests (**6.2.9**), and

k) Endurance test (**6.2.10**).

6.1 Type Tests

6.1.1 *Preliminary Inspection* — The principal components of the motor shall be dimensionally checked against the relevant drawings and a record made of the parts liable to wear. A check shall be made to ensure that the brushes are bedded over the full arc for at least 80 percent of their axial width. Any running required to condition the commutator surface shall be done prior to the commencement of the tests. Insulation resistance shall also be measured before the commencement of other tests. The weight of the motor, the distance of its centre of gravity from the mounting flange, and the polar moment of inertia of the rotor shall be determined. Checks to ensure conformity with requirements specified in IS : 8946-1978* shall be made.

6.1.2 *Cold Resistance Test* — The cold resistance of all the windings shall be measured at room temperature corrected to standard temperature of 27°C (*see* IS : 196-1966†) and checked for conformity with declared value.

6.1.3 *Load Test*

6.1.3.1 For a range of output torques from zero to 150 percent of the rated torque, the current and speed shall be measured at the maximum and minimum terminal voltages specified in IS : 7854-1975‡, or as specified in the individual specification.

6.1.3.2 If the motor is reversible, these tests shall be made for both the directions of rotation. The currents and speeds shall be plotted on a torque domain and the values at rated torque thus derived for each direction of rotation shall be within ± 5 percent of their respective average value.

6.1.3.3 The efficiency and output power shall be calculated and plotted on torque base.

6.1.3.4 In case the motors are supplied complete with gears, the tests laid down in **6.1.3.1** to **6.1.3.3** shall also be carried out with the gearing removed. The efficiency of the gearing at various torques shall be derived and plotted.

6.1.4 *Stall Test* — With the armature locked against rotation, measurements of current and torque shall be recorded and the values plotted over range of applied voltage from zero to maximum or as high as is practicable without overheating or deterrent damage to winding. The test shall be repeated with the armature locked in several other positions.

6.1.5 *Temperature Test*

6.1.5.1 For the purpose of this test, the continuous rated motors shall be run without stopping, at the rated torque and maximum test voltage applied for a period until steady state temperature condition is reached. Short time rated motors shall be run continuously at rated torque and maximum test voltage applied for a period equal to 110 percent of their time rating. During this test in the case of small motors of frame size less than 50 mm, care shall be taken to see that no seepage of heat takes place from the mounting base by providing thermal insulating material in mounting.

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*General requirements for rotating electrical machinery for aircraft.

†Specification for atmospheric conditions for testing (*revised*).

‡Voltages and frequency for aircraft electrical systems.

6.1.5.2 Records of output torque, speed, current, voltage, quality of commutation, coolant, if any, and the level of temperature of all the field windings, brush and commutation shall be maintained throughout the test. Any other measurements considered necessary as per the individual specification of the motor shall also be taken.

6.1.5.3 The methods of measurement of temperature rise shall be as specified in IS : 4722-1968*.

6.1.6 *Commutation Test* — The commutation of the motor shall be assessed under extreme conditions of load and speed.

6.1.7 *Overload Test* — Following the temperature test (*see* **6.1.5**), tests to check the overload capacity in compliance with the requirements given in **3.1.2** shall be done.

6.1.8 *Insulation Resistance Test* — At the conclusion of the overload tests and at the same time when the windings are hot, the insulation resistance of each of the windings shall be measured at a dc voltage of 500 V; the value obtained shall not be less than 2 megohms.

6.1.9 *Altitude Test*

6.1.9.1 Under conditions of air temperature, pressure, humidity and cooling applicable to its duty at the values normally prevailing at the maximum rated altitude, the motor shall function at maximum voltage and rated torque for a period of 100 h in 10 cycles of ten hours each, each cycle being preceded by 2 h of run at sea level condition.

6.1.9.2 Intermittently rated motors shall be tested under the relevant load conditions and duty cycle specified and the temperature records during the test shall be maintained.

6.1.9.3 For air cooled machines, records of the following measurements shall be made:

a) Terminal voltage,

b) Input current,

c) Air pressure drop across machine,

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*Specification for rotating electrical machines.

d) Inlet air pressure,

e) Mass flow air,

f) Inlet dew point,

g) Temperature of brush placed at a point remote from cooling air point (at intervals not exceeding one hour), and

h) Initial and final length of each brush.

NOTE — The performance wear on these brushes at high altitude at which the aircraft may be expected to operate shall be satisfactory.

6.1.10 *Endurance Test*

6.1.10.1 Prior to the commencement of this test, the dimensions of parts liable to wear shall be measured and the ambient temperature noted. No maintenance or major adjustment of any kind shall be performed on the motor during this test, except that new brushes, if necessary, shall be fitted. Reversible motors shall be tested in each direction of rotation for 50 percent of the total test period.

6.1.10.2 The motor shall be subjected to test for a period as follows:

a) *Continuous duty* — A total running period of 1 000 hours in cycles of 10 hours run followed by 2 h rest.

b) *Motors of frequent and infrequent duty nature* — A minimum running period of 75 h with at least 25 one hour cooling cycles.

c) *Limited life* — Running for 5 percent of the total running period specified in (a) and (b) as appropriate.

6.1.10.3 At the conclusion of tests in **6.1.10.1** and **6.1.10.2**, the insulation resistance of the motor shall be measured (when the windings are in hot condition itself); and it shall not be less than 1 megohm. Failure to obtain this value shall be explored thoroughly and record in detail shall be made.

6.1.10.4 The motor shall be run at no load and rated load conditions and the current and speed recorded. Also, the motor shall be examined for any unusual wear and obvious visual defects of the components.

6.1.11 *Acceleration Test* — The motor shall function satisfactorily after being subjected to acceleration test as specified in the individual equipment specification.

6.1.12 *Vibration Test* — The motor shall function satisfactorily after being subjected to vibration test as specified in the individual equipment specification.

6.1.13 *Temperature, Pressure Test*

6.1.13.1 The motor shall function satisfactorily when subjected to pressure, temperature appropriate to the classification grading declared by the manufacturer as specified in IS : 8252 (Part II)-1980*.

6.1.13.2 During the functioning tests for the appropriate category, the motor shall be run at average speed for a few minutes to ensure that all moving parts and brushes are free. For the low temperature functioning tests, the temperature of the chamber may be lowered so that the motor is at its minimum declared ambient temperature.

6.1.13.3 Insulation resistance of the motor shall be measured before and after the tests in **6.1.13.2**.

6.1.14 *Environmental Tests*

6.1.14.1 The motor shall be tested for the following and shall comply with the requirements in the specification referred to:

a) Water proofness as per IS : 8252 (Part VI)-1976†.

b) Salt corrosion as per IS : 8252 (Part X)-1979‡.

c) Dust and sand as per IS : 8252 (Part VII)§, and

d) Fluid contamination as per IS : 8252 (Part XXII)||

6.1.15 *Radio Interference Test* — The motor shall be tested for radio noise interference in accordance with IS : 8252 (Part XIX)¶ or as specified in the individual specification.

6.1.16 *Compass Interference Test* — The motor shall be subjected to tests for compass safe distance in accordance with IS : 8252 (Part XVIII)-1978**.

6.2 Routine Tests

6.2.1 *Component Check* — All components and subassemblies of each motor shall be checked for workmanship and for conformity with approved drawings.

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*Environmental tests for aircraft equipment: Part II Temperature, pressure and humidity.

†Environmental tests for aircraft equipment: Part VI Waterproofness.

‡Environmental tests for aircraft equipment: Part X Salt mist.

§Environmental tests for aircraft equipment: Part VII Dust and sand (*under preparation*).

||Environmental tests for aircraft equipment: Part XXII Fluid contamination (*under preparation*).

¶Environmental tests for aircraft equipment: Part XIX Radio interference (*under preparation*).

**Environmental tests for aircraft equipment: Part XVIII Magnetic influence.

6.2.2 *Resistance Test* — The resistance of all the windings measured at standard room temperature as per IS: 196-1966* shall be within 10 percent of the declared value.

6.2.3 *Preliminary Run Test* — Prior to commencement of tests, the motor shall be allowed to run for a sufficient period at a suitable speed so as to ensure proper bedding of brushes over the commutator.

6.2.4 *Over-Speed Test* — The motor shall be run at 125 percent of the maximum operating speed when it is hot, for a period of 3 min; there shall be no abnormal noise or vibration.

6.2.5 *Load Test* — The test shall be conducted as specified in **6.1.3**.

6.2.6 *Insulation Resistance Test* — The motor shall be subjected to insulation resistance test as specified in **6.1.8**, immediately after the test in **6.2.5**.

6.2.7 *High Voltage Test* — The motor shall be subjected to this test with an ac voltage of 500 V at 50 Hz applied in between the earth point (or body in case the body is isolated and not connected with any of the terminals) and all the current carrying parts. No inadvertent failure or breakdown shall occur.

6.2.8 *Temperature Test* — This test shall be carried out on representative samples taken from production batches. The test shall be conducted as specified in **6.1.5**.

6.2.9 *Environmental Tests* — These tests shall be carried out on representative samples taken from the production batches. The tests shall be carried out as specified in **6.1.14**.

6.2.10 *Endurance Test* — The test shall be carried out on representative samples taken from production batches, and shall be as specified in **6.1.10**.

6.3 Number of Samples for Type Tests and Criterion for Conformity — The number of samples to be taken for type tests and during production tests shall be as specified by the type approving authority. If a sample fails during any of the tests, it shall be closely inspected and dismantled, and if necessary, a report on the probable cause of failure shall be made to the approving authority. With the approval of the approving authority, the test may be repeated on not more than one additional sample during type test and not more than two additional samples from each production batch, before a final decision on acceptance/rejection is taken.

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*Specification for atmospheric conditions for testing (*revised*).